CAPABILITIES OF AIR FORCE WASTEWATER TREATMENT PLANTS IN COMPLYING WITH PROJECTED REGULATORY REQUIREMENTS

THESIS

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AFIT/GEE/ENV/93S-7

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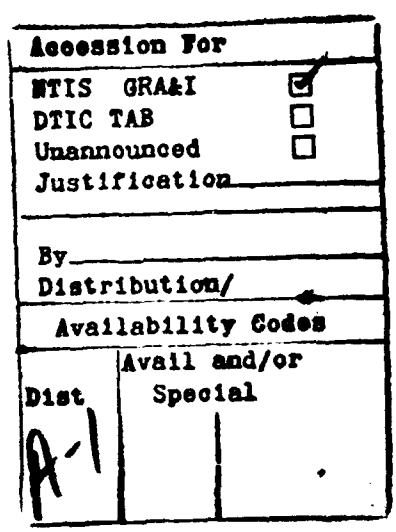

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THESIS

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Steven R. Ford
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List of Acronyms

AFB	-	Air Force Base
AFI	-	Air Force Instruction
BOD	-	Biochemical Oxygen Demand
CFR	-	Code of Federal Regulations
COD	-	Chemical Oxygen Demand
CONUS	-	Continental United States
CWA	-	Clean Water Act
DO	-	Dissolved Oxygen
DOD	-	Department of Defense
EPA	-	Environmental Protection Agency
FWPCA	-	Federal Water Pollution Control Act
FY	-	Fiscal Year
MGD	-	Million gallons per day
mg/l	-	milligrams per liter
MILCON	-	Military Construction
NOV	-	Notice of Violation
NPDES	-	National Pollutant Discharge Elimination System
OMTAP	-	Operations and Maintenance Training Assistance Program
POC	-	Point of Contact
POTW	-	Publicly Owned Treatment Works
RBC	-	Rotating Biological Contactor
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids

USAF	-	U.S. Air Force
VOC	-	Volatile Organic Compound
WQA	-	Water Quality Act
WWTP	-	Wastewater Treatment Plant

Abstract

Since the Air Force has wastewater treatment plants (WWTPs) on numerous bases, one of the major environmental regulations that directly affects the Air Force is the Federal Water Pollution Control Act (FWPCA). The FWPCA 1972 amendments set forth a series of National goals regarding water quality. The main mechanism for achieving these goals was the National Pollutant Discharge Elimination System (NPDES). NPDES is a permit program requiring wastewater dischargers to limit the quantity of pollutants discharged into a receiving water.

Based upon increasing environmental awareness in both the public and private sectors, it is probable that the standards that drive the NPDES discharge limits are apt to become more stringent. This research effort predicts changes in future NPDES permit requirements, and evaluates the capabilities of Air Force WWTPs to meet those requirements.

Specific future requirements, such as numerical limits on regulated pollutants, are not known. Since local water quality assessment is becoming the determining factor in specifying permit requirements, modeling of each receiving body of water is done to determine site specific numerical limits. Hence, as NPDES permits come up for renewal, the outcomes of these modeling efforts will decide specific

discharge criteria.

However, it was qualitatively found that permit requirements will likely include de-chlorination, nutrient removal, and possibly metals removal. It was also discovered that several states are now developing new water quality assessment criteria. These new criteria could set a precedent, and may be used to set future requirements nationwide.

CAPABILITIES OF AIR FORCE WASTEWATER TREATMENT PLANTS IN COMPLYING WITH PROJECTED REGULATORY REQUIREMENTS

I. Introduction

General Issue

In October 1990, Secretary of Defense Dick Cheney, in his Environmental Management Policy Memorandum, stated, "I want the Department of Defense [DOD] to be the Federal leader in agency environmental compliance and protection" (3:335). Also, in a speech in September of 1990, Secretary Cheney submitted four Defense Environmental Goals, the first of which was: "Achieve full and sustained compliance with federal, state and local environmental laws and regulations" (3:335).

Since the Air Force has wastewater treatment plants (WWTPs) on numerous bases, one of the major environmental regulations that directly affects the Air Force is the Federal Water Pollution Control Act (FWPCA), more commonly known as the Clean Water Act (CWA)(23:816-903; 24:1566-1611). The FWPCA applies to all facilities which discharge wastewater into waterways of the U.S. The FWPCA was originally passed by Congress in 1948, and has since been

amended several times, most notably in 1972, 1977 and 1987. The most recent amendments are also referred to as the Water Quality Act (WQA) (13:4-9,36; 24:4).

The purpose of the FWPCA, as concisely stated in the 1972 amendments, is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters..." (24:816). The FWPCA 1972 amendments set forth a series of National goals, the first of which states, "It is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985" (24:817). The main mechanism for achieving this goal was the National Pollutant Discharge Elimination System (NPDES). NPDES is a permit program requiring wastewater dischargers to "disclose the volume and nature of their discharges, authorizing the EPA [Environmental Protection Agency] to specify the limitations to be imposed on such discharges...". It also sets up a system of reporting and monitoring in order for the EPA to determine compliance or non-compliance with the specified discharge limits (2:69). While the goal of complete pollutant elimination by 1985 was unrealistic and not attained, the NPDES remains the primary mechanism for regulating wastewater discharges.

While the EPA has overall national responsibility for oversight of the CWA, section 510 of the Act declares that enforcement is the responsibility of the individual states,

providing the state discharge standards are at least as stringent as the federal standards (13:13). Today, there are still several states that do not have NPDES authority. The water quality programs in those states are administered by the regional EPA office (2:96). However, even those states that have the authority to administer the program within their respective boundaries, are still required to have their programs monitored and assessed by the EPA (2:96.)

Like many environmental regulations, the CWA directs the Administrator of the EPA to continually identify improved methods for detecting and measuring the effects of the pollutants (5:3). This requirement, combined with increasing public awareness and concern for the environment, has lead to more stringent pollution discharge standards. For example, when the FWPCA was originally passed, there was little guidance given in the area of defining specific toxic pollutants. After the 1972 amendments, toxic pollutants were still vaguely defined. For this reason, and due to limited personnel resources, "the EPA focused mainly on five conventional pollutants when it developed the effluent limitations required by the Act" (2:70). After several lawsuits against the EPA, and after the 1977 and 1987 amendments, there are currently 65 categories of priority pollutants (including 126 specific chemical substances)

further classified under 34 industrial categories that include over 700 subcategories (2:71).

Based on these past trends and the nation's increasing concern with environmental issues, it is clear the standards that drive the NPDES discharge limits are apt to become increasingly stringent.

Specific Problem

The Department of Defense has already predicted that new, more stringent standards will impact DOD WWTPs. William H. Parker III, former Deputy Assistant Secretary (Environment), Department of Defense, testified to Congress:

> Increasing regulations, more stringent permit requirements, and increasing interest in estuaries will continue to strain DOD's aging wastewater treatment facilities and will necessitate construction of new and/or improvements to existing facilities. (5:192)

Though Mr. Parker forecast requirements for new facilities, there has been no comprehensive investigation into the contaminant removal capabilities of the current WWTP facilities and how they could be expected to handle the projected standards. Also, there has been no comprehensive evaluation of current Air Force NPDES standards nor of how regional regulatory trends and proposed legislation and regulations may be used to predict what the new standards will be (1).

Research Objective

The purpose of this research is to predict future NPDES permitting requirements for CONUS Air Force bases and to evaluate the capabilities of current Air Force WWTPs in meeting those requirements.

Scope

This research will only include Air Force domestic wastewater treatment requirements, and will only include WWTPs with NPDES permits. Other permits, such as local pretreatment permits, will not be analyzed. This research will not include the assessment of stormwater requirements, nor will it include industrial wastewater treatment requirements, except in those cases where there may be an industrial discharger on a base that sends its waste stream to a base plant which is designed primarily for domestic sewage.

Investigative Questions

The following questions will address the specific problem:

1. What are the current NPDES permit discharge standards for those bases that hold such permits?
2. What are the current capabilities of the WWTPs on those bases?
    - 2a. What types of treatment technologies are currently being used and what are their contaminant removal capabilities?

2b. What are the current actual pollutant levels being discharged by these bases?

3. What are the best estimates of future requirements considering regional trends, regulator opinion, and individual base assessments?

4. How does the evaluation in #2 compare with the estimates in #3?

5. What options are available (technically and managerially) to resolve the differences determined in #4.

Methods used to answer these questions and the methods of data analysis are addressed in Chapter III.

II. Literature Review

Overview

This chapter will review the laws, regulations, and DOD directives that govern wastewater treatment in the U.S. Air Force. It will also briefly review the history of water pollution legislation, and how that legislation affects Air Force pollution control efforts. The NPDES permitting program will also be reviewed. Compliance problems will then be addressed and finally, wastewater treatment technologies will be generally described.

Federal Laws and Regulations

The number of Federal environmental laws and regulations has exploded over the past decade. Col Stephen G. Termaath, former Assistant for Environmental Quality, Office of the Deputy Assistant to the Secretary of the Air Force, observed:

> Environmental professionals face the impossible task of remaining current on an explosion of environmental regulations. Since 1981, the Environmental Protection Agency has produced over 2,000 new rules. In 1986 alone, 8,500 pages of new regulations were produced. EPA's share of the Code of Federal Regulations (CFR) can be found in a dozen or more volumes. Technical guidance manuals that supplement these rules are measured in linear feet. The sheer volume and increasing rate at which regulations are promulgated place great stress on the management of environmental programs. State programs to which we are also subject have grown in a similar fashion. While the private sector must comply with the same standards, few private sector companies attempt to

operate in all 50 states. (6:223)

This statement gives an idea of what DOD environmental managers must face regarding regulatory requirements.

Federal Water Pollution Control. Water pollution in the United States was first addressed in the 1899 Rivers and Harbors Act. This Act prohibited dumping of "solid objects" in the Nation's rivers and harbors. The purpose of this act was primarily to curtail the creation of obstructions for the shipping industry (26:36).

It was not until 1948 that a comprehensive statement of federal interest in clean water programs was put forth. This statement declared that it was "...the policy of Congress to recognize, preserve, and protect the primary responsibilities and rights of the states in controlling water pollution" (13:4). However, there were no federal goals or objectives. The U.S. Surgeon General was tasked to formulate programs to eliminate or reduce pollution of interstate waters. It was up to the states to enforce the water programs within their respective boundaries (13:4).

During the 1950's and 1960's, most of the federal water pollution legislation dealt with programs of fiscal assistance to dischargers, mostly in the form of loans or grants (13:5). During this time, to keep some control over the way federal monies were being spent, the government acquired additional responsibilities in legislating and

enforcing water pollution controls.

In 1972, Congress passed the Federal Water Pollution Control Act Amendments (FWPCAA). With these amendments, the Federal Government, through the still-fledgling EPA, assumed the dominant role in directing and defining water pollution control programs (13:9). The amendments had the objective of restoring and maintaining

> ...the chemical, physical, and biological integrity of the nation's waters by eliminating the discharge of pollutants into navigable waters of the United States by 1985. (24:952)

The FWPCA of 1972 initiated a federal program to restore and maintain the nation's waters. To meet this objective, the 1972 amendments created the National Pollutant Discharge Elimination System (NPDES) which requires all wastewater dischargers to obtain a permit from the EPA in order to discharge wastewater into any navigable waterway. Specifically, the permit program requires

> ...dischargers to disclose the volume and nature of their discharges, authorizing EPA to specify the limitation to be imposed on such discharges, imposing on discharger an obligation to monitor and report as to their compliance or noncompliance with the limitations so imposed, and authorizing EPA and citizen enforcement in the event of non-compliance. (2:69)

The NPDES was established to regulate and reduce pollutants discharged from point sources. It is administered by the EPA and states that have been delegated responsibility (25:10). Permits also require facility

operators to submit to their regulating agencies monitoring reports that list the types and amounts of specific pollutants actually discharged at specific monitoring points (25:12). EPA's regional offices oversee the delegated states' activities and administer the program in those states where program responsibility has not been delegated. EPA regions oversee state activities by making on-site evaluations of state programs and by requiring states to submit quarterly non-compliance reports (25:11).

Since NPDES permits are required by both federal and non-federal wastewater treatment facilities, there is no theoretical difference between compliance requirements for federal and non-federal facilities. However, in the 1970's, federal facilities continued to operate under the concept of sovereign immunity. This means that Federal facilities were immune from penalties, especially by the individual states, for non-compliance situations (17:5). However, the practice of sovereign immunity ended in 1978 with the issuance of Executive Order 12088 that mandated that all federal facilities comply with all applicable standards dealing with pollution abatement (17:5). More specifically, this order required the administrators of federal facilities to present a plan to the director of the Office of Management and Budget "...for improvements necessary to meet federal, *state*, interstate and *local* water quality standards" (17:5).

In short, this order effectively removed sovereign immunity from federal facilities with regard to the FWPCA and mandated compliance with all state and local water pollution control laws.

Basis for NPDES Standards. The 1972 amendments clearly referred to two types of dischargers: direct industrial dischargers and publicly owned treatment works (POTWs). The majority of Air Force WWTPs can be considered analogous to POTWs in that the influent streams are made up mostly of domestic sewage. There are also Air Force treatment plants that are considered direct industrial dischargers. However, as mentioned earlier, these plants are to be excluded from this study.

According to the 1972 amendments, discharges from POTWs were to achieve technology driven effluent limitations based on secondary treatment, as defined by the EPA, and any more stringent limitations imposed by state law (2:86).

Table 1 shows the EPA defined secondary treatment levels as given in the 1972 amendments. Technology-based standards set minimum requirements for dischargers. However, if these standards are not adequate to achieve a particular water quality in the receiving body, then more stringent water quality-based standards must be used (13:46). Water quality-based limitations will be discussed later.

TABLE 1.
SECONDARY TREATMENT STANDARDS

(2:86; 27)

Pollutant	% Removal	Concentration	
		Monthly avg	Weekly avg
BOD	85	30 mg/l	45 mg/l
Suspended Solids	85	30 mg/l	45 mg/l
Fecal Coliform		200/100 ml	400/100 ml
pH	6.0 - 9.0 std units		

The above pollutant categories are four of the so-called "conventional" pollutants that were focused on almost entirely by the EPA for developing permits. A fifth that was added later was oil/grease. Toxic pollutants were almost never addressed (2:71). This emphasis was changed to some extent by the 1977 amendments and drastically by the 1987 amendments.

Clean Water Act Amendments of 1987. With the passage of the Clean Water Act Amendments in 1987 (also called the Water Quality Act or WQA), the regulatory responsibility for clean water came almost full circle. Whereas the states had primary responsibility during the 40's, 50's and 60's, the federal government took major responsibility in the 1972 FWPCA. Some of this responsibility returned to the states in the 1987 WQA amendments (10:55).

One major area of emphasis of the WQA amendments deals with toxic pollutants. Before 1987, few states had numeric

water quality criteria for any of the 126 toxic pollutants that Congress required the EPA to regulate under Sec 307 of the 1972 FWPCAA (13:40). Toxic pollutants were thought to be under the exclusive jurisdiction of the EPA, which could regulate on a chemical-by-chemical basis. But because of the stringent testing and extensive procedures required by Section 307 of the FWPCA, EPA did not establish a workable program to control the discharge of toxic pollutants between 1972 and 1977 (2:71). This led to a major lawsuit against the EPA, the outcome of which created the outline for the toxic control strategy used in the 1977 and 1987 amendments (2:71). However, because states are allowed to establish their own water quality standards, and because EPA's function is merely to ensure that each state program is technically sound and fully implemented, toxic control programs may not be uniform nationwide (9:xxiii).

The 1987 amendments reflected Congressional concern for toxics in waste streams (12:38). As stated above, the states are required to identify water bodies that will not meet water quality standards because of point source toxic discharges. The states were then to submit programs for increasing the quality of those water bodies. If the states could not develop an acceptable program for controlling the toxics in the wastestreams for these waters, the EPA would do it for them (2:90) Although this control strategy for

toxics is aimed primarily at industrial dischargers, it has set a precedent for how EPA can control the water pollution programs of individual states. This method of control could very well be applied to domestic dischargers.

Also, it is important to note that Congress is trying to decrease local differences for highly "visible" contaminates. For example, a bill now before Congress would mandate uniform nationwide dioxin standards. Currently, state standards vary by as much as three orders of magnitude (10:55).

Air Force Policy

Air Force Regulation (AFR) 19-1, Pollution Abatement and Environmental Quality, gives general guidance for the disposal of domestic wastewater:

> Make all practical efforts to use municipal or regional waste collection or disposal systems as the preferred method for disposal of wastewater from AF facilities. When use of such a system is not feasible or appropriate, do whatever is necessary to satisfactorily dispose of such wastes. (8:6)

Additionally, there is an effort currently underway at Air Staff to publish Air Force Instructions (AFI) on compliance issues dealing with wastewater and other environmental programs. Currently, these instructions are only in the initial draft stages (18).

DOD Compliance Problems

Keeping in compliance with state and federal regulations has been an ongoing problem for DOD installations. Federal facility water pollution compliance, and in particular DOD facility compliance, has been the object of several studies over the past few years. These studies have not had favorable outcomes. According to one report, federal facilities' rate of non-compliance with priority program requirements is twice that of non-federal industrial facilities (25:3).

However, an important point is that while the total number of compliance problems may be high, only 17% of them were linked to ineffective performance of the treatment process (25:29). Other causes cited were inadvertent discharges into treatment process, malfunctioning equipment, and routine cleaning and maintenance (25:29).

This implies that most of the treatment facilities in the Air Force are capable of meeting the current effluent standards, but do not because of non-process related incidents such as malfunctioning equipment, operator error, and accidental discharges of pollutants into the plant. More recently, in FY 92, there were a total of 62 NOV's given out by regulatory agencies to Air Force bases for water quality noncompliance. Of these, 25 were for discharging pollutants in exceedance of permit requirements.

The others were for items such as operator errors, unpermitted discharge, spills, poor maintenance, and administrative problems (1).

Compliance Enforcement. There are two types of enforcement actions against non-compliant facilities: informal and formal. Informal actions include telephone calls, letters and notices of violation (NOVs). In the private sector, formal actions include administrative orders and judicial action. EPA is also authorized to bring civil action and seek civil penalties (25:14). However, EPA's formal enforcement response differs for federal facilities.

> It is EPA's policy to negotiate compliance agreements with non-compliant federal facilities. EPA does not sue federal facilities or assess penalties for permit violations. Delegated states, on the other hand, can use the same enforcement procedures against federal facilities as they use against non-federal facilities. (25:15)

Hence, even though the EPA does not sue federal facilities for non-compliance, the states can.

Air Force Problems. The Chief of Staff of the Air Force has said that the "measure of success for environmental programs is zero NOVs" (15). Unfortunately, federal facilities have problems in achieving this goal that are peculiar to government entities. Because of budgetary requirements and procurement procedures used by the federal government, wastewater compliance issues that require monetary outlays often cannot be resolved rapidly. Indeed,

regulators and government auditors have identified the federal budget process and procurement procedures as the most important underlying factor in compliance violations at federal facilities when major expenditures are required.

Future Requirements

It is generally acknowledged in the literature that wastewater requirements will become more stringent in the future. In his article, "Toxic Regulations Take Hold", Koorse states:

> During the next few years, new EPA and state water toxics regulations promulgated under the authority of the CWA will result in increasingly stringent effluent limits in the NPDES permits being issued to POTWs. In addition to the strict toxics limits, even stricter limits are on the horizon -- bioaccumulation, bioconcentration, biological criteria, sediment criteria and wildlife criteria -- that ultimately may produce additional standards to be imposed on POTWs. (12:36)

For example, though states are still working on establishing effluent criteria for their most toxic waste streams, EPA published in 1990 its first biennial plan for review and revision of existing categorical effluent standards and promulgation of new categorical effluent standards. This planning process is to identify categories of sources discharging toxic and non-conventional pollutants for which effluent standards have not been promulgated. New standards and revisions will be promulgated at various times between 1992 and 1995 (7:302-303). Though these

categorical standards are primarily for industrial wastewater treatment plants, this example gives an idea of how rapidly new requirements are being promulgated.

There are also non-governmental agencies that are organizing and providing ideas for future legislation. One such organization, known as Water Quality 2000, consists of 86 organizations -- ranging from such diverse groups as the Natural Resources Defense Council to the Chemical Manufacturers Association -- who have reached a consensus on the current major water quality problems. Work groups for defining applicable pollutant criteria have already been formed for five categories, including toxic constituents (16:1541).

Another area in which pollution control is likely to increase is nutrient removal. Nutrients are defined as inorganic phosphorus and inorganic nitrogen compounds (27). While there is no federally mandated discharge levels for these pollutants, the states were encouraged to take them into consideration when monitoring for compliance (27).

The removal of these nutrients is especially important when eutrophication of the receiving water body is a problem (14:251). Removal of nutrients from the waste stream usually requires the use of a tertiary, or advanced, treatment process, which will be described below. Currently, advanced treatment processes are not commonplace

on Air Force WWTPs.

Another reason one might expect the wastewater effluent standards to change is that the WQA is currently being amended once again. A comprehensive reauthorization bill has been introduced to Congress and some single-issue bills have also been introduced. Congressional concerns have focused on the current laws' shortcoming in controlling water pollution (10:55). However, the direction and emphasis that will be given in the reauthorization are still in doubt. Benjamin Grumbles, a member of the subcommittee on water resources, has stated: "The next year or two is critical as to where we will go with respect to the CWA. Congress needs more input because they are not sure what to do next" (20:22).

Water Pollution Control Trends. Since water quality programs are being increasingly delegated to the individual states, it is commonplace for states to look at the programs of other states as models for their own programs. With this in mind, wastewater pollution control programs can be similar for neighboring states, or for states within the same area of the country. For example, in the Great Lakes region, the EPA and the states in that area have cooperated on an initiative to improve the water quality in the Great Lakes. This initiative has resulted in some of the most stringent requirements yet developed for wastewater

dischargers. In the article "Designing Goals for the Great Lakes", Smith and Carr state:

> "Acceptance of the Great Lakes Initiative constitutes acceptance of its policies and methods. Once supported by precedent, these methods could be applied across the U.S. Therefore, all current and past dischargers of chemicals, inside and outside the Great Lakes watershed, should pay close attention to the GLWQG [Great Lakes Water Quality Guidance]." (19:51)

Hence, it is possible for states to duplicate standards and practices of other states. This also gives credence to the possibility of finding similar regulatory requirements among neighboring states.

Types of Treatments

Wastewater treatment plants are usually designated as providing primary, secondary or advanced treatment. These are described below.

Primary. Primary treatment uses simple physical processes such as screening and sedimentation (14:241). Screening removes large floating objects such as rags, sticks and whatever else might damage the pumps or clog small pipes in the plant. After screening, the wastewater passes into a grit chamber to allow sand and other heavy material to settle out. However, the residence time in the grit chamber is too short to allow lighter, organic materials to settle (14:243).

From the grit chamber, the sewage passes to a primary clarifier tank (also sometimes referred to as a settling

tank or equalization basin) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity. This results in the removal of 50 to 65 percent of the suspended solids and 25-40% of the Biochemical Oxygen Demand (BOD). Also in this tank, the material that floats to the top is skimmed off (14:243).

After this treatment, the effluent is often disinfected with chlorine and then released (14:243). In the early 70's, this process was the only treatment given to the domestic wastewater of over 50 million people in the United States (14:241).

Secondary Treatment. Secondary treatment is the next level of wastewater treatment. The Clean Water Act of 1972, and the amendments of 1977, required at least secondary treatment for all POTWs (14:241). The main purpose of secondary treatment, which typically consists of biological treatment, is to remove BOD at a higher level than what was achievable by simple sedimentation (14:243).

After the primary treatment process (but before the disinfection stage), the wastewater begins the secondary treatment stage. There are four biological methods commonly used for secondary treatment. All use microorganisms to degrade the organic wastes into stabilized, low-energy compounds (14:243).

Trickling Filters. Trickling filters are the

oldest form of engineered biological treatment (22:621). Trickling filters are composed of a large bed of rock or plastic media. The rocks (or plastic media) are covered with a layer of biological "slime". The wastewater is distributed over the bed by some type of sprinkling system. As the wastewater trickles over the media, the organisms in the slime consume or degrade the organic constituents.

After this process, the effluent, along with any of the slime that has sloughed off (biomass), enters a secondary clarification tank where the biomass settles out and is either recycled or removed (14:244; 22:623). After secondary clarification, the effluent can be filtered, chlorinated and discharged.

Rotating Biological Contactors. Rotating biological contactors, or RBCs, are similar to trickling filters. However, instead of sprinkling the waste stream over the organisms, the organisms are maintained on large rotating disks. The disks stand vertically and are partially submerged in a tank containing the wastewater. As the disk turns, the organisms are exposed to and degrade the organics in the waste stream. RBCs are usually designed with several in a series to efficiently treat the waste stream (22:631). After this stage, and similar to the trickling filter process, the effluent flows into a secondary clarifier for the removal of any solids.

Activated Sludge. In this process, the wastewater undergoes primary treatment and is then piped into a biological unit called an aeration tank. In the aeration tank, the waste stream is brought into contact with a suspended microbial culture that degrades the organics. This degradation process is similar to the degradation that occurs in the trickling filters and RBCs. The two major differences of activated sludge are: 1) the microorganisms are suspended in water instead of on a static media, and 2) air is constantly being pumped into the aeration tank to increase the oxygen supply to the microbes. These two items dramatically increase the efficiency of the microbes in degrading the organics (14:245).

After a residence time of 6-8 hours in the aeration tank, the effluent flows to a secondary clarifier where the biomass separates and is either recycled or wasted.

Oxidation Ponds. Masters defines oxidation ponds as:

> "...large, shallow ponds, typically 1-2 meters deep, where raw or partially treated sewage is decomposed by microorganisms. The conditions are similar to those that prevail in a eutrophic lake. The ponds can be designed to maintain aerobic conditions throughout, but more often the decomposition taking place near the surface is aerobic, while that near the bottom is anaerobic. Ponds are easy to build and manage, they accommodate large fluctuations in flow, and they can provide treatment that approaches that of conventional biological systems, but at a much lower cost." (14:249)

Oxidation ponds can also be used as polishing ponds to increase effluent quality after conventional secondary treatment (14:249).

All of the above biological processes are acceptable in terms of conventional pollutant removal. Table 2 shows removal efficiency for three types of biological treatment

TABLE 2.
CONSTITUENT REMOVAL EFFICIENCY IN PERCENT
FOR CERTAIN TREATMENT PROCESSES*

(21:170)

PROCESS	BOD	TSS	P**	ORG-N***	N****
Activated sludge	80-95	80-90	10-25	15-50	8-15
Trickling filter	65-85	60-85	8-12	15-50	8-15
RBC	80-85	80-85	10-25	15-50	8-15

* This information for oxidation ponds was not available.
** Total Phosphorus
*** Organic Nitrogen
**** Ammonia Nitrogen

processes. While this table also shows that these processes do remove some portion of the total nutrient loading, this does not ordinarily constitute "nutrient removal".

Advanced Treatment. Advanced treatment is anything after primary and secondary treatment, except chlorination. The purpose of tertiary/advanced treatment is to: 1) more fully remove the BOD from the effluent, 2) remove nutrients, such as phosphorus and nitrogen, or, 3) remove various toxic substances such as metals (14:250). Many different advanced

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Advanced Treatment. Advanced treatment is anything after primary and secondary treatment, except chlorination. The purpose of tertiary/advanced treatment is to: 1) more fully remove the BOD from the effluent, 2) remove nutrients, such as phosphorus and nitrogen, or, 3) remove various toxic substances such as metals (14:250). Many different advanced

treatment processes exist and they are usually specifically designed for a particular waste stream. Some of the more common advanced treatment methods include gas stripping, filtration, reverse osmosis, and certain anaerobic techniques (22:529-541;23:229-243).

Nutrients. Nutrients in wastewater can be removed by biological or chemical methods. Biological mechanisms for nutrient removal require a high degree of control over certain wastewater characteristics, namely pH and flowrates. Nutrient removal by chemical methods, while efficient, can cause unwanted side-effects, such as an increase in the amount of sludge generated.

While biological and chemical nitrogen removal methods have their distinct advantages and disadvantages, biological removal methods are generally recommended for removing phosphorus and biological nitrogen. Ammonia nitrogen in the wastewater, however, can be effectively removed by volatilization of the gaseous ammonia by air stripping (21:735). Organic nitrogen can be removed by nitrification/de-nitrification. First nitrogen is converted to nitrate. This is done by certain nitrifying organisms. These nitrates are then converted to nitrogen gas. Because of the special conditions under which this process takes place, nitrification/de-nitrification is normally accomplished in basins or tanks which are separate from the

other biological processes (21:711-713).

Biological nitrogen removal has the following benefits: high potential removal efficiency, high process stability and reliability, relatively easy process control, low land requirements, and moderate cost (21:711). The major advantage of biological over chemical is the amount of sludge produced. Chemical removal creates relatively large amounts of sludge that must be handled and disposed of (21:711).

Phosphorus removal is typically accomplished by the addition of chemical, most notably alum. While this is an effective removal treatment, it does increase the amount of sludge generated. Hence, in recent years, biological processes have been developed for the removal of phosphorus. These processes usually employ combinations of anaerobic, anoxic, and aerobic zones. Some of these processes have the added advantage of also having high nitrogen removal rates (21:731). For more information concerning these processes the reader is encouraged to consult ref. 21.

Metals. Heavy metal removal can only be brought about by precipitation. One such process requires sodium hydroxide to be added to increase the pH of the wastewater. This causes the heavy metals to become insoluble. A coagulant is also added to assist in creating flocs, or coagulated particles. These then settle out and form a

sludge, which must then be removed. After this occurs, acid is added to the wastewater to bring in back to the required pH range. Normally, metals removal is only done at industrial wastewater treatment plants; however, heavy metals removal at POTWs is being increasingly investigated by the EPA (9).

Disinfection. Disinfection has historically been accomplished with the use of chlorine. However, recent studies have shown the high levels of residual chlorine in wastewater could have adverse affects on the biota of the receiving water (21:343). Specifically, this concern is with the formation of trihalomethanes and chloroform, which have both been shown to be carcinogenic (22:560). Hence, methods to lower the amount of chlorine in the discharged effluent have been implemented at many WWTPs. There are two acceptable methods for lowering the chlorine residual in wastewater: lowering the amount of chlorine added, or removing the chlorine, usually with the use of sulfur dioxide (21:343). Lowering the amount of chlorine added has advantages and disadvantages. The advantages are no capital costs to install a de-chlorination unit, and lower chemical costs due to the decrease in chlorine compound usage. The main disadvantage is that by using less chlorine, bacteria destruction will decrease, meaning higher fecal coliform counts, as well as other bacteria, in the effluent stream

(19:11). Unfortunately, it is unlikely that this method will reduce the residual chlorine to regulatory amounts.

De-chlorination also has advantages and disadvantages. By having a dedicated de-chlorination process, additional chlorine may be added for increased disinfection, if needed. The main disadvantage is the capital cost involved, and also, in some WWTPs, room for adding additional processes may be limited.

Alternative disinfection techniques are also being used, most notably ozone and ultra-violet (UV) light. Ozone is generally believed to be more effective than chlorine (21:350). However, since ozone generation requires relatively large amounts of electricity, operating cost has been a major factor in keeping it from being used widely. UV light has also been shown to be an effective disinfectant (21:351). However, to be effective the liquid must be "thinned out" in order for the light to penetrate and react with the bacterial cells (21:352). This means that special units must be installed in the effluent channel to limit the liquid thickness. These units must be in an enclosed structure to protect the electrical equipment used (21:352).

Summary

This chapter has reviewed some of the history and important aspects of the water pollution issues confronting the US Air Force. It has also described some of the more

common wastewater treatment methods.

The main point of this review has been to show that over time, wastewater standards have become, and may continue to become, more stringent. The 1987 WQA Amendments and the revised water quality standards they require can be expected, during the next 5 to 10 years, to increase the stringency of treatment requirements imposed on dischargers (2:93). This will place increasing importance on the capability of the treatment plants to achieve and maintain the quality of the their effluent.

III. Methodology

Overview

In this chapter, the problem being researched, and the methods that will be used to solve the problem, will be briefly reviewed and discussed. The investigative questions are restated and the methods of answering these questions are enumerated. Information concerning the data used will be given. Also, the base-level and regulator surveys that were used to gather data will be discussed.

General Issue

All federal facilities must comply with laws and regulations pertaining to environmental protection. Over the past decade, due to increased public awareness and concern for the environment, technological advances, and legislative requirements placed on the EPA, environmental regulations have become increasingly stringent.

Since the Air Force operates wastewater treatment plants, regulations concerning wastewater discharge standards are among those that directly affect the Air Force. These regulations are expected to become more stringent in the coming years. The new, stricter standards will be applied through NPDES permits.

Specific Problem

Although stricter discharge limits are expected, there has been no comprehensive review of current Air Force wastewater treatment plant pollutant removal capabilities to deal with these new standards. Also, there has been no investigation into what future regulations may be, nor of how regional regulatory trends and/or proposed legislation and regulations may be used to predict these new standards.

Investigative Questions

The following questions will address the specific problem:

1. What are the current NPDES permit discharge standards for those bases that hold such permits?

2. What are the current treatment capabilities of the WWTPs on those bases?

    2a. What types of treatment technologies are currently being used and what are their contaminate removal capabilities?

    2b. What are the current actual pollutant levels being discharged by these bases?

3. What are the best estimates of future requirements considering regional trends, regulator opinion and individual base estimates?

4. How does the evaluation in #2 compare with the estimates in #3?

5. What options are available (technically and managerially) to resolve the differences found in #4?

Data Collection

To answer the investigative questions, information must be obtained from several sources. Information on the current treatment technologies used in the Air Force will be obtained from the Air Force water and wastewater treatment inventory that was completed as a thesis project by Capt Vincent E. Renaud, USAF in 1987 (17). This inventory lists CONUS Air Force bases and their respective wastewater treatment methods. Also, information from a thesis by Capt James R. Brady, (USMC), in 1990 (5) will be used to determine which Air Force bases have NPDES permits. These two studies will also be used for deciding which Air Force bases to contact for the survey, which will be discussed later in the chapter.

Using the treatment inventory as a guide, information will be collected from literature on the overall capabilities of these different treatment methods. This predicted capability will be compared with how the WWTPs are actually performing using data gathered from several Air Force WWTPs. These data will consist of the NPDES monitoring reports sent by the base to the responsible regulatory agency.

The next step will involve obtaining the actual requirements of the plants as specified in the base's NPDES permit. NPDES permit information will be obtained from the

individual bases.

From these permits, trends will be looked for that may yield information as to possible future requirements in the permitting process. Trends, if found, will probably be defined from region-to-region. For example, states in the region of the Great Lakes initiative discussed in Chapter 2 may all have very similar discharge requirements. And if one state had more lenient requirements, it may be safe to assume that at some point in the future, it too will be adopting the more stringent requirements of that region.

Decision Criteria

In order to define which bases would be included in the study, two criteria were developed. First, a base had to have a WWTP that was a direct discharger; that is, a plant that discharged directly into a navigable waterway of the U.S. This would indicated that the WWTP is operating under a NPDES permit. Second, the WWTP had to treat primarily domestic waste. As stated earlier, industrial wastewater treatment plants were excluded from the study. From the two theses mentioned above, a list of 17 bases was generated.

Telephone Survey

A telephone survey of base-level personnel and regulators will be done to determine best estimates of upcoming water pollution control requirements. The base-

level survey serves a twofold purpose. First, it will be used to validate certain information obtained from Renaud's treatment process inventory. The inventory update is especially important due to the time that has elapsed since the inventory was completed in 1988. Second, the base-level estimates as to future NPDES requirements can be established. Base survey questions are listed in Appendix A.

The telephone surveys of the regulators will ask many of the same questions. The regulators will be from those agencies (either state or federal) who have regulatory oversight of the bases that have been surveyed. These data may be used to discover differences between the regulator's perceptions and the base's perceptions regarding future requirements. Regulator survey questions are listed in Appendix B.

IV. Findings

Overview

This chapter will summarize the information obtained through the base-level/regulator surveys, as well as data gathered from individual base permits. Items from the surveys that will be summarized are, a)wastewater treatment trains, b)current NPDES permit limits and any discernible trends, c)base-level perceptions as to possible changes in future permits, d)regulator perceptions as to possible changes in future permits and any discernible trends, e)problems the bases are now having with NPDES compliance, and, f)future plans for each base's wastewater treatment program. Individual results from each base are contained in appendix E.

Survey Details

The surveys of the bases and the regulators were accomplished by telephone. This took place between 20 April and 2 June, 1993. Appendix A contains the questions asked in the base survey and appendix B contains the regulator survey questions. Appendix C lists the points of contact for the bases surveyed. Appendix D lists the points of contact at the regulatory agencies surveyed.

In order to be surveyed, a base had to meet 2

requirements. They are:

1. The base wastewater treatment plant must be a direct discharging Active Duty Air Force CONUS facility under NPDES jurisdiction.

2. The wastewater treatment plant must treat primarily domestic sewage.

A list of the bases meeting these criteria, as well as their secondary treatment method, are listed in Table 3.

TABLE 3.

LIST OF BASES SURVEYED
AND THE SECONDARY TREATMENT TYPE

BASE	2° TREATMENT TYPE
Arnold AFB	Trickling filter
Beale AFB	Trickling filter
Columbus AFB	Trickling filter
Ellsworth AFB	Trickling filter
Grand Forks AFB	Oxidation ponds
Grissom AFB	Activated sludge
K. I. Sawyer	Rotating biological contactors
Luke AFB	Trickling filter
McGuire AFB	Trickling filter
Minot AFB	Oxidation ponds
Moody AFB	Trickling filter
Patrick AFB	Activated sludge
Robins AFB	Trickling filter
Scott AFB	Trickling filter
Shaw AFB	Activated sludge
Tinker AFB	Trickling filter
Whiteman AFB	Trickling filter

At this time, there are two bases listed on the survey that are on the base closure/realignment list or are being considered for closure. Grissom AFB is slated for realignment in FY 94. It will become an Air Force reserve base. K.I. Sawyer AFB has been proposed for closure but as of July 1993, has not yet been officially listed for closure.

Wastewater Treatment Trains

As can be seen from Table 1, the majority (65%) of the Air Force treatment plants surveyed use trickling filters as the secondary treatment method. All of these trickling filter plants have primary and secondary settling tanks. Figure 1 shows a typical trickling filter treatment train. All of the trickling filter plants surveyed, with one exception, chlorinate the final effluent. Only one trickling filter plant has a de-chlorination process. Most have an aeration step, which increases the dissolved oxygen content in the water, prior to final discharge.

The plants that use activated sludge as the secondary treatment method also have primary settling tanks, secondary clarifiers, and chlorination of the effluent. Of the activated sludge plants surveyed, only Patrick AFB has a de-chlorination process. Figure 2 diagrams a typical activated sludge treatment train. Shaw AFB passes its effluent

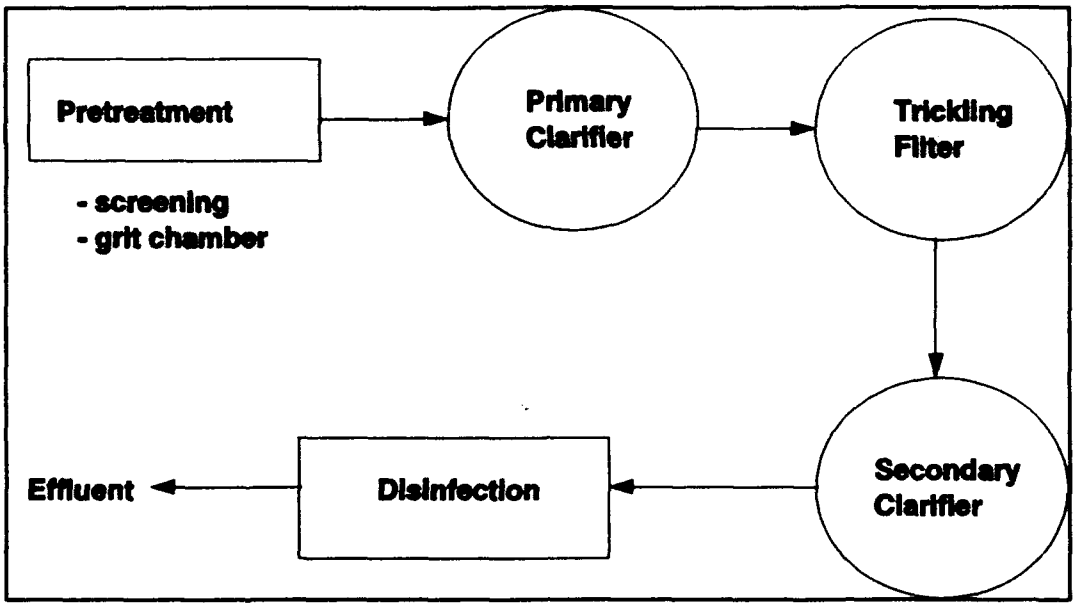

Figure 1. Typical process diagram for a trickling filter plant.

through a multi-media filter (gravel, sand, and activated carbon) prior to the chlorination step. Also, Patrick AFB's activated sludge plant has tertiary sand filters.

The two bases that use oxidation ponds use simple screening prior to the pond. One difference in these two bases is the discharge intervals. Minot AFB only discharges 3-4 times a year. This effluent is discharged into a dry streambed that eventually leads to a reservoir. However, the base indicated that the reservoir was quite distant and they were not sure if any of the effluent reached it. Grand Forks AFB discharges continually into a wetland/wildlife

refuge.

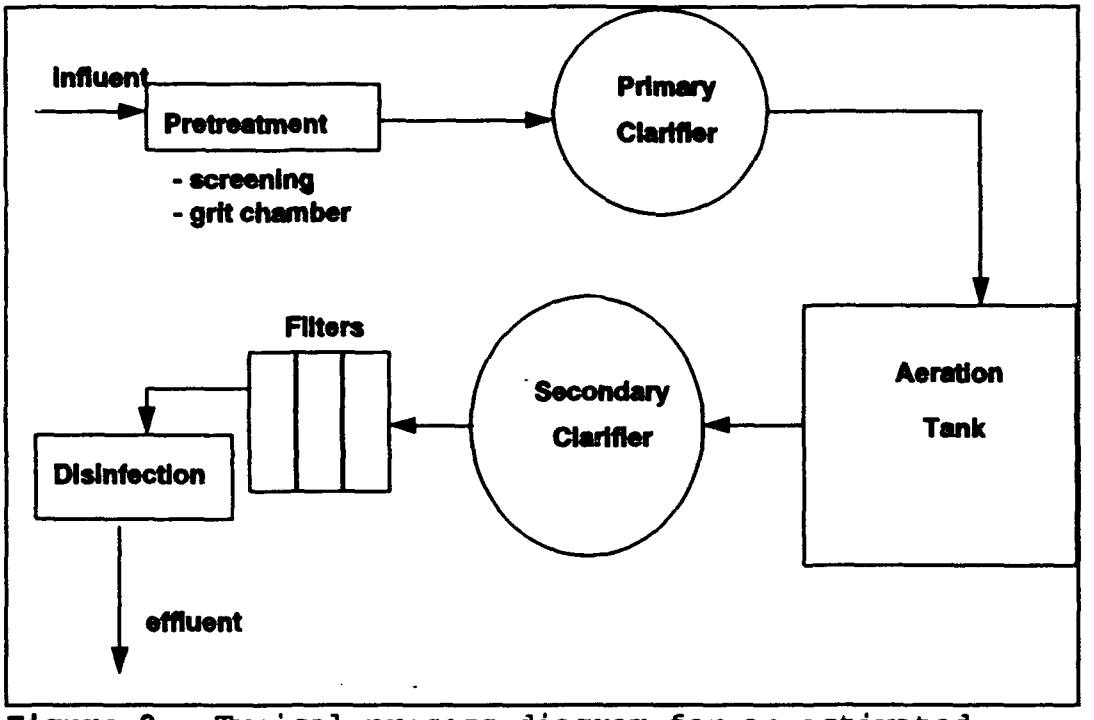

Figure 2. Typical process diagram for an activated sludge plant.

K.I. Sawyer is the only base that uses rotating biological contactors as the secondary treatment method. It is also one of the most advanced domestic treatment plants in the Air Force. Not only is the RBC process very efficient in removing BOD, but the plant is also designed to remove both phosphorus and ammonia. The plant also chlorinates and de-chlorinates the effluent before discharge and can pass the effluent through tertiary sand filters. The treatment train diagram looks very much like the activated sludge diagram,

shown in Fig. 2, with the rotating disks in the place of the aeration basin.

Current NPDES Requirements

As part of the base-level survey, the bases were asked to submit their current NPDES permits and their monthly monitoring reports. Of the 17 bases in this study, only 10 submitted this information. Of the bases that responded, several sent copies of both the NPDES permit and the monitoring report. Others sent in the monitoring report only. This may cause some inaccuracy as some requirements may be on the permit that would not necessarily be on a monthly monitoring report, (for instance, quarterly biomonitoring). For consistency, the information summarized in this section is taken from the monthly monitoring reports, except where noted.

Current NPDES permits for all of these bases are very much alike, as would be expected. However, all permits are water-quality based as opposed to technology-based, hence, there are some differences in the individual permits due to local water quality conditions. Therefore the receiving body plays the determining factor in deciding which pollutants, in addition to the conventional pollutants, are to be regulated in the discharge permit. The receiving body also plays the dominant role in determining the numerical levels of all pollutants.

Regarding the conventional pollutants, all permits have limitations for BOD, total suspended solids, and fecal coliform, though the actual numerical limit varies from base to base. Not all permits regulate for oil/grease. Parameters other than the conventional pollutants vary. They include such items as ammonia, phosphorus, residual chlorine, dissolved oxygen and biomonitoring. Robins AFB also has requirements for chemical oxygen demand (COD), phenols and various metals. McGuire AFB, which has the most stringent requirements of any plant in this study, must also sample for a variety of metals, pesticides, acid compounds, and other constituents. Information on individual bases concerning these items is located in appendix E.

Base-level Estimates of Future Requirements

Of the 17 bases surveyed, eight indicated that they were expecting changes in their NPDES permits. However, of these eight, only four had some idea of what those changes may entail. Some bases, such as Arnold AFB, have permits that were recently renewed; therefore, it is too early to forecast future permit requirements. Some bases said there would be changes simply because that is the perceived trend, not because of any specific knowledge. Table 4 gives a breakdown by base of anticipated future requirements.

TABLE 4.
BASE-LEVEL ESTIMATES OF FUTURE REQUIREMENTS

BASE	NPDES RENEW DATE	EXPECT CHANGE	ANTICIPATED FUTURE REQUIREMENTS
Arnold AFB	1997	NO	
Beale AFB	1995	YES	UNKNOWN
Columbus AFB	1994	YES	De-chlorination, lower BOD levels
Ellsworth AFB	1995	NO	
Grand Forks AFB	1994	NO	
Grissom AFB	*	YES	Lower chlorine residual, ammonia
KI Sawyer	**	NO	
Luke AFB	1994	NO	
McGuire AFB	***	NO	
Minot AFB	1994	YES	UNKNOWN
Moody AFB	1995	YES	UNKNOWN
Patrick AFB	****		
Robins AFB	1993	Yes	De-chlorination, lower BOD levels, possibly lower COD and TSS
Scott AFB	1994	No	
Shaw AFB	1993	No	
Tinker AFB	1993	YES	Metals, BOD, TSS, toxicity
Whiteman AFB	****	YES	UNKNOWN

* See appendix E-6.
** See appendix E-7.
*** See appendix E-9.
**** See appendix E-12.

Regulator Estimates of Future Requirements

The regulators surveyed were almost evenly split in their assessment of future requirements, with eight saying they were expecting no change and six indicating that some change was probable. Of these six, five gave specific parameters that would probably be included in future permits. Additionally, one regulator indicated that the base in his jurisdiction (Tinker AFB) may be required to monitor their domestic sewage for heavy metals, such as mercury, arsenic, cadmium and chromium, even though the waste stream containing these substances should go to the base industrial waste treatment facility. Table 5 summarizes the regulator responses.

Other Trends. There were no apparent trends found from the regulator survey based on geographic distribution. This may be due to the small number of sample responses from each region of the country.

None of the regulators would speculate on future numerical limits for any pollutant. They indicated this information would come from the results of modeling the receiving body to determine optimal pollutant loading.

From Tables 4 and 5, it is apparent that de-chlorination is going to be playing a major part in future permit requirements. Since there are currently only five plants that either de-chlorinate the effluent or are

TABLE 5.
REGULATOR'S ESTIMATES OF FUTURE REQUIREMENTS

STATE	BASE	EXPECT CHANGE	ANTICIPATED REQUIREMENTS
Tennessee	Arnold AFB	NO	
California	Beale AFB	NO	
Mississippi	Columbus AFB	NO	
South Dakota	Ellsworth AFB	NO	
North Dakota	Grand Forks AFB	Maybe	Nutrients
Indiana	Grissom AFB	YES	De-chlorination, possibly ammonia
Michigan	KI Sawyer	NO	
Arizona	Luke AFB	*	
New Jersey	McGuire AFB	**	
North Dakota	Minot AFB	NO	
Georgia	Moody AFB	YES	De-chlorination, toxics (Biomonitoring)
Florida	Patrick AFB	***	
Georgia	Robins AFB	YES	De-chlorination
Illinois	Scott AFB	NO	
South Carolina	Shaw AFB	NO	
Oklahoma	Tinker AFB	YES	Biomonitoring, lower fecal C.
Missouri	Whiteman AFB	YES	Nutrients

* State of Arizona regulators were not contacted. See appendix E-8.
** Dependent on wetlands experiment
*** Florida regulators were not contacted. See Appendix E-12 for more information.

upgrading to include de-chlorination, and there are at least

five more that expect de-chlorination requirements in the future, it may be reasonable to assume that requirements to install de-chlorination facilities will increase as more NPDES permits come up for renewal. Table 6 summarizes the current and predicted de-chlorination situation.

TABLE 6.
CHLORINATION/DE-CHLORINATION REQUIREMENTS

Base	Currently Chlorinate Final	Currently De-chlorinate Final	De-chlorination requirement predicted
Arnold AFB	Yes	No	No
Beale AFB	Yes	No	No
Columbus AFB	Yes	No	Possible
Ellsworth AFB	Yes	No	No
Grand Forks AFB	No		
Grissom AFB	Yes	No	Yes
KI Sawyer AFB	Yes	Yes	
Luke AFB	yes	no	no
McGuire AFB	Yes	Yes	
Minot AFB	No		
Moody AFB	Yes	No	Yes
Patrick AFB	Yes	Yes	
Robins AFB	Yes	No	Possible
Scott AFB	Yes	Yes	
Shaw AFB	Yes	No	Yes
Tinker AFB	No		
Whiteman AFB	No		No

Nutrient removal is another area where there is no discernible trend based on geographical region. Some of the regulators indicated that nutrient-removal requirements will be determined by modeling as the permits come closer to renewal. However, these same regulators said that they did not expect changes concerning nutrients. Table 7 shows the current and future nutrient requirements for each base.

Compliance problems.

As was stated earlier, the receipt of an NOV from a regulatory agency is only one indication of compliance problems. Severity of NOVs and requirements for receiving an NOV vary from state to state, and sometimes even among different regulators within the same agency. Hence, there are various kinds of NOVs. Some are given by the regulatory agency for a single incident and can be cleared within a short amount of time. Other NOVs are for more chronic problems that may take months or years to clear. Only four of the bases surveyed stated that they were working under an NOV from their respective regulatory agency. These NOVs are for releasing effluent that had pollutant levels above the permit requirements for the following parameters: fecal coliform, TSS, oils/grease, metals, and BOD. Two of the plants with NOVs are doing some type of upgrade that will hopefully solve these problems. The third plant said they

had no plans to upgrade, but rather are trying to solve their particular problems through operational and management improvements.

TABLE 7.
CURRENT AND PREDICTED NUTRIENT REQUIREMENTS

BASE	CURRENTLY MONITOR FOR PHOSPHORUS / NITROGEN?	REGULATOR ANTICIPATED FUTURE REQUIREMENT FOR P/N.	BASE ANTICIPATED FUTURE REQUIREMENT FOR P/N.
Arnold AFB	no/yes	no/no	no/no
Beale AFB		no/no	no/no
Columbus AFB	no/no	no/no	no/no
Ellsworth AFB	no/no	no/no	no/no
Grand Forks AFB	no/yes	possible	no/no
Grissom AFB	no/yes	no/yes	no/yes
KI Sawyer AFB		no/no	no/no
Luke AFB		no/no	no/no
McGuire AFB	yes/yes	N/A	N/A
Minot AFB	no/no	no/no	no/no
Moody AFB		no/no	no/no
Patrick AFB		N/A	N/A
Robins AFB	no/yes	no/no	no/no
Scott AFB		no/no	no/no
Shaw AFB	no/yes	no/no	no/no
Tinker AFB	no/no	no/no	no/no
Whiteman AFB		yes/yes	no/no

The fourth plant is McGuire AFB in New Jersey. As mentioned earlier, they will solve their problem by discharging to a new treatment plant at Ft Dix.

Future Plans for AF Wastewater Treatment Plants

Most of the bases stated that they were planning some type of change in the near future. The types of changes mentioned can be categorized into two areas: changes or upgrades to the treatment facility itself or changes in the method of discharge. Eight bases stated that they were modifying the physical plant in some way. These modifications include everything from increasing capacity of equalization basins to complete upgrades. Table 8 indicates what the individual bases are planning.

As is shown on the table, five plants are not necessarily changing the physical processes, but rather, how they discharge. With one exception, these plants are trying to eliminate the NPDES permit by either tying in to a regional facility, another federal facility, or going to 100% wastewater reuse on the base and only have a discharge permit for emergencies. The one exception, Whiteman AFB, is working closely with the state to experiment with applying their effluent to a wetlands area. The goal of this experiment is to determine the efficacy of using wetlands as tertiary treatment. The plant will still retain its NPDES permit.

TABLE 8.
FUTURE PLANS FOR AIR FORCE WWTPS.

BASE	Future Plans
Arnold AFB	Increasing capacity, adding redundancy
Beale AFB	Trying for 100% reuse, will eliminate NPDES permit
Columbus AFB	NONE
Ellsworth AFB	NONE
Grand Forks AFB	Increase capacity
Grissom AFB	NONE
KI Sawyer AFB	NONE
Luke AFB	Upgrading to activated sludge, UV disinfection, trying for 100% reuse. Will eliminate NPDES permit
McGuire AFB	Connecting to another facility, will eliminate NPDES permit
Minot AFB	Currently increasing capacity
Moody AFB	Possible connection to county POTW, would eliminate NPDES permit
Patrick AFB	Connecting to regional facility, will eliminate NPDES permit
Robins AFB	upgrade to splitter box
Scott AFB	NONE
Shaw AFB	Chlorination/de-Chlorination unit
Tinker AFB	NONE
Whiteman AFB	Wetlands discharge

NOTE: These changes are only for domestic sewage treatment.

Summary.

This section has presented the findings of two surveys. The first survey was intended to determine base-level predictions as to future NPDES requirements. The second was to determine the predictions of regulatory agencies as to future NPDES requirements. In most cases, there was some agreement between the base and the regulator for that base.In general, anticipated regional trends of significance in either current NPDES permits or future requirements was not established. However, shortfalls between current Air Force WWTP capabilities and predicted requirements were found. These shortfalls include lack of adequate de-chlorination facilities, nutrient removal capabilities, and possibly metals removal.

V. Conclusions and Recommendations

Overview

The overall objective of this research effort was to predict possible changes in future NPDES permit requirements, and to evaluate the capabilities of Air Force WWTPs in meeting those requirements. This goal was partially achieved. The base and regulator surveys revealed general areas where NPDES limits may become more stringent. Specifics, such as numerical limits on regulated pollutants, were not given. Therefore capabilities of WWTPs to meet future requirements could only be generally predicted. One reason for this lack of detail is the nature of the regulatory process. Since local water quality assessment is becoming the determining factor in specifying permit requirements, inferences cannot be drawn from past permits, even within the same state.

This chapter will derive conclusions from the literature review of Chapter 2 and the findings in Chapter 4 as they relate to the investigative questions posed in Chapter 1. It will also recommend several solutions to the potential shortfalls in treatment capability that have been found from the surveys. Finally, it will present areas for future research.

Conclusions

Research Question One. What are the current NPDES permit discharge standards for those bases that hold such permits?

Overall, NPDES permit discharge standards vary over a relatively large range, both in types of contaminants regulated and in the actual numerical limits. Also, since local water quality concerns are the overriding factor in determining NPDES discharge levels, NPDES requirements vary dramatically, even within the same state. This increases the compliance burden for Air Force planners since they must now work with fifty individual regulatory agencies, in addition to the EPA. However, in general, NPDES requirements for Air Force bases in the U.S. can be placed into three categories: conventional pollutants, nutrients, and miscellaneous. The miscellaneous category includes items that require the addition of special treatment processes such as metals removal. With only a few exceptions, conventional pollutant requirements are consistent with the secondary treatment limits defined in Chapter II. The other categories vary widely and are receiving-water specific.

Research Question Two. What are the current capabilities of the WWTPs on those bases? What types of treatment technologies are currently being used and what are

their contaminant removal capabilities? What are the current actual pollutant levels being discharged by these bases?

All of the Air Force bases surveyed have adequate facilities for treating the conventional pollutants. Trickling filter, activated sludge, oxidation ponds and rotating biological contactors are all proven technologies that meet the secondary treatment requirements (ref. 27). However, in general, Air Force WWTP capabilities are extremely limited in treating additional pollutants. While some plants are capable of removing nutrients or chlorine, the majority of plants are not equipped to do this.

Research Question Three. What are the best estimates of future requirements considering regional trends, regulator opinion, and individual base assessments?

As was discovered in Chapter 4, there were no regional trends identifiable from the regulators nor the information obtained from the bases. However, the Great Lakes initiative mentioned in Chapter 2 shows how a regional coalition of states can develop criteria for restoring and maintaining the quality of a common receiving body of water through a collectively-developed wastewater discharge permitting program.

Base and regulator estimates are very general in terms of possible future requirements. However, it is possible

that future permit requirements will include de-chlorination, nutrient removal, and metals removal. It was also discovered that several states are or will be developing new water quality assessment criteria.

Research Question Four. How does the evaluation in #2 compare with the estimates in #3?

As stated earlier, only a few Air Force WWTPs have the capabilities to meet the expected future requirements of their respective states. One of the biggest shortfalls will be in the area de-chlorination. Only 5 of the bases could meet any future de-chlorination requirements while 5 more may actually be compelled to do so.

Another shortfall will be in nutrient-removal capability. Only 2 of the plants surveyed are currently equipped to efficiently remove either nitrogen or phosphorus.

Additionally, if there are going to be future requirements for metals removal, only one of the plants is equipped specifically for metals removal.

Research Question Five. What options are available (technically and managerially) to resolve the differences determined in #4.

Possible Technical Solutions.

De-chlorination. As mentioned in Chapter 2, several methods exist for removing residual chlorine in the

discharged effluent. Ideally, decreasing the amount of chlorine used initially has the most advantages, and bases should be encouraged to work with their regulatory agency in determining whether or not this is feasible. Also, as noted earlier, this probably would not decrease the residual chlorine to regulatory levels. Hence, for existing plants, de-chlorination, most probably with SO_2, would be the recommended course of action. For new plants, alternative disinfection techniques may be applicable.

Nutrients. Nitrogen and phosphorus removal by biological methods, while requiring a large up-front capital expenditure, will no doubt be the most beneficial to Air Force WWTPs. This is because of efficiency in removing the nutrients, and also because there will be no post process requirements (i.e. excess sludge handling and disposal).

Metals Removal. Heavy metal removal is the most uncertain of the anticipated requirements. Bases should work very closely with regulators in determining the need for metals removal. This requirement, if implemented, will require large expenditures to construct the appropriate facilities. Furthermore, as new WWTPs are constructed, they should, at a minimum, provide an area where these facilities could be built, if future needs dictate.

Possible Management Solution

OMTAP. The Operations and Maintenance Training Assistance Program (OMTAP) is a program developed by the Air Force Civil Engineering Support Agency to assist WWTPs with meeting compliance requirements by improving the O&M of the plant. The OMTAP process consists of three separate steps. First, a contractor will visit the WWTP to complete a diagnostic exam of the operations and maintenance procedures used at the plant. The second step is for the contractor to evaluate possible problems, give solutions to those problems, and also give any additional suggestions to help the plant operate more efficiently. Third, the contractor will return to the plant one year after implementation of the solutions/ideas to evaluate.

To date, very few WWTPs in the Air Force have taken advantage of this program. However, the potential of success by using OMTAP can be very great, as was the case at Beale AFB. (See appendix E-2)

Recommendations for Further Research

Since this study covered only domestic wastewater treatment plants, a similar study covering industrial wastewater treatment plants should also be done. Also, pretreatment requirements for those plants that discharge into a regional facility should be examined and evaluated.

More research could be done on evaluating different

techniques for nutrient removal as well as disinfection for Air Force plants.

Another area for related research is the applicability of using wetlands for wastewater treatment. A study of using wetlands as a tertiary treatment process Air Force wide could be beneficial. The on-going experiment at Whiteman AFB can be used as a case study.

Also, since many of the states said that they would be using new modeling techniques to assess receiving water quality, perhaps a study of the different kinds of models which are being used would be appropriate.

Appendix A
Base Survey Questions

1. What is your treatment process?
   primary

   secondary

   advanced/final (chlorination/dechlorination)

2. What is your daily average flow?

3. Who is a POC at your regulatory agency?

4. When does your NPDES permit come up for renewal?

5. Are you expecting a change in your NPDES discharge limits?

6. Any plans for changes in order to meet new requirements?

7. Are you planning on upgrading?

8. Do you feel the upgrade will meet projected requirements?

9. Do you have any NOVs from your regulatory agency?

10. What are the toughest parameters you have to meet?

11. Where does your discharge go?

12. Any problem dischargers on your base?

13. Would it be possible to send me a copy of the DMR reports for the past 2-3 months

Appendix B
Regulator Survey Questions

1. What do you expect in the way of new NPDES requirements within the next two years?

    1a. Are these firm, or do you negotiate? If negotiable, what aspects, limits or time to compliance.

2. Do you expect different requirements for federal facilities as opposed to POTWs.

3. What limits are the toughest to meet for the Air Force base in your jurisdiction?

4. Does the Air Force base in your jurisdiction have any problems that are out of the ordinary for a typical POTW?

5. Do you foresee any tightening of pretreatment requirements which may affect bases that are connected to regional facilities?

Appendix C
Points of Contact at Bases

Base: Arnold AFB, TN
POC: Bill Dunne
Title: Director, Environmental planning
ph: (DSN) 340-4345

Base: Beale AFB, CA
POC: Greg Miller
Title: Water Quality Engineer
ph: (DSN) 368-2641

Base: Columbus AFB, MS
POC: Lt Todd Joachim
Title: Bioenvironmental Engineer
ph: (DSN) 742-2284

Base: Ellsworth AFB, SD
POC: Bill McCullough
Title: Environmental Coordinator
ph: (DSN) 675-2680

Base: Grand Forks, ND
POC: Wayne Koop
Title: Chief, Environmental Branch
ph: (DSN) 362-4590

Base: Grissom AFB, IN
POC: Marlene Seneca
Title: Environmental Engineer
ph: (DSN) 928-4579

Base: K.I. Sawyer AFB, MI
POC: Mr. Sustarich
Title:
ph: (DSN) 472-2312

Base: Luke AFB, AR
POC: Ms Matthews
Title:
ph: (DSN) 853-3621

Base: McGuire AFB, NJ
POC: Ed Viveiros
Title: Wastewater Engineer
ph: (DSN) 440-2692

Base: Minot AFB, ND
POC: Tom Atkinson
Title: Environmental Engineer
ph: (DSN) 453-4824

Base: Moody AFB, GA
POC: Mr. Crenshaw
Title: Chief, Environmental Contract Plans
ph: (DSN) 460-3069

Base: Patrick AFB, FL
POC: Larry Smith
Title: Environmental Planning
ph: (DSN) 853-6157

Base: Robins AFB, GA
POC: Rodney Reed
Title: Environmental Engineer
ph: (DSN) 468-9777

Base: Scott AFB, IL
POC: Bruce Cope
Title: Environmental Engineer
ph: (DSN) 576-4226

Base: Shaw AFB, SC
POC: Dan Luton
Title: Environmental Engineer
ph: (DSN) 965-5214

Base: Tinker AFB, OK
POC: Marshall Dixon
Title: Environmental Engineer
ph: (DSN) 884-4111

Base: Whiteman AFB, MO
POC: Ed Lens
Title: WWTP foreman
ph: (DSN) 975-2251

Appendix D
Points of Contact at Regulatory Agencies

State: California
POC: Mark Bapkin
ph: (916) 255-3061

State: Georgia
POC: Joseph Cane
ph: (404) 656-4887

State: Georgia
POC: Ken Shephard
ph: (912) 430-4144

State: Illinois
POC: Gary Wolffe
ph: (217) 782-0610

State: Indiana
POC: Joseph Krieger
ph: (317) 232-8706

State: Oklahoma
POC: Norma Aldrich
ph: (405) 231-2565

State: Michigan
POC: Jack Riequist
ph: (906) 228-6561

State: Mississippi
POC: Steve Spangler
ph: (601) 961-5070

State: Missouri
POC: Richard Locks
ph: (314) 822-0101

State: North Dakota
POC: Jane Pfieffer
ph: (701) 221-5210

State: North Dakota
POC: Steven Smokie
ph: (701) 221-5210

State: South Carolina
POC: Tim Eleazer
ph: (803) 734-5247

State: South Dakota
POC: Kent Woodmansy
ph: (605) 773-4216

State: Tennessee
POC: Saya Qualls
ph: (615) 523-0625

Appendix E-1

Arnold AFB

Wastewater Treatment Train. The wastewater treatment train at Arnold AFB consists of screening, equalization, trickling filters, secondary clarification and chlorination. After chlorination, the effluent is discharged into a creek. Average flow through the plant is .25 MGD.

Current NPDES Limits. The current NPDES permit for Arnold AFB contains effluent limitations for BOD, TSS, ammonia, pH, fecal coliform, chlorine residual, DO, and settleable solids. Table E-1-1 shows the effluent limitations on these parameters as well as the actual effluent levels. These levels were averaged over a three month period. Additionally, according to the NPDES permit, Arnold AFB must also biomonitor the final effluent. These tests are to be conducted once every two months for one year, and then once every six months for the duration of the permit. Also, the base is required to sample fish tissue for PCBs.

Biomonitoring Estimates for Future Requirements. Arnold's NPDES permit was renewed in 1992, hence it will not need to be renewed until 1997. However, two items in the 1992 permit are currently on appeal with the state regulatory agency. These items are a biomonitoring requirement and a PCB

TABLE E-1-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR
ARNOLD AFB

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l
BOD	30/45	9/14
Ammonia	5/8	*
TSS	30/45	9/18
fecal col	200/400 (per 100 ml)	12/144
DO	1.0 min	6.5 min
Res. Cl.	.5	.5
Sett. solids	100 ml/l	0

* Ammonia levels were not reported

monitoring requirement. The base feels that these two items are not needed in their permit.

As for upcoming requirements, the base indicated that the next NPDES renewal is too far in the future and is unable to project any changes.

Regulator Estimates for Future Requirements. The state regulatory agency also said that permit renewal is too far in the future to make any type of prediction.

Compliance problems. The base has no outstanding NOV's on their wastewater treatment plant. According to the base personnel, the plant has no problems treating the influent waste stream. The base has no "problem dischargers" that

occasionally discharge difficult to treat substances, or substances that may cause the plant to break its limits.

Future Plans. Arnold is currently planning to upgrade the WWTP in 1994. This upgrade will consist of increasing the capacity of the plant and to add redundancy to several of the treatment processes.

Appendix E-2

Beale AFB

Treatment train. The treatment train at Beale consists of a grit chamber, primary settling tank, trickling filter w/secondary clarification, aeration and chlorination. The daily average flowrate is between .7 and 1.1 MGD.

Current NPDES limits. Neither the base NPDES permit nor the NPDES monitoring report was received from the base.

Base Estimates for Future Requirements. The base indicated that they were expecting minor changes to their permit, but it was too early for specifics. In general, they did indicate that the state is going to undertake an Effluent Receiving Water Quality Assessment (ERWQA) for all waters in the state of California. Presumably, the outcome of this assessment will play a part in any future effluent quality requirements.

Regulator Estimates for Future Requirements. The regulatory agency for Beale AFB indicated that they were expecting no changes to Beale's NPDES permit. Since the permit renewal date is not until 1995, they said it is too far off to predict anything specific. However, they also indicated that the results of the ERWQA may be a major player in any future permits.

Compliance Problems. The base is not working under any kind of NOV for their domestic wastewater program. Beale

recently corrected a major problem with certain constituents that were coming from the base photo lab. This problem was identified and corrected with the use of the OMTAP program discussed in Chapter 5.

Future Plans. Beale AFB is trying to eliminate their domestic wastewater NPDES permit by going to 100% wastewater reuse. If successful, the base would need an NPDES discharge permit only for emergency discharges. Since Beale is located in an arid location, the state is fully backing this plan.

Appendix E-3

Columbus AFB

Wastewater Treatment Train. The Columbus AFB WWTP consists of a settling basin, trickling filters with secondary settling and final chlorination. The base does not de-chlorinate. The average flowrate through the plant is between .7 and .8 MGD.

Current NPDES Permit. The NPDES permit for Columbus has effluent limitation requirements for BOD, TSS, pH, fecal coliform, and residual chlorine. Table E-3-1 shows the numerical limits for these parameters as well as the actual levels in the effluent. The actual levels were averaged over a three month period.

TABLE E-3-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR COLUMBUS

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	30/45	9/10
TSS	30/45	17/29
Fecal Coliform	200/400	< 10
pH	6-8.5 std units	6.5-7.3
Resid. Chlorine	1.0 max	.16

Base Estimates for Future Requirements. The NPDES permit for Columbus comes up for renewal in 1994. The base indicated two possible changes for the renewed permit. These changes may impose lower BOD levels and de-chlorination.

Regulator Estimates for Future Requirements. The regulator for Columbus AFB said he was not expecting any specific changes in the base's NPDES permit. Interestingly, he was the only regulator in this study to say that any changes may be dependent on the CWA reauthorization.

Compliance Problems. The base currently does not have any NOV's for its wastewater treatment program. Also, the base indicated that it has no difficulties in meeting its permit requirements.

Future Plans. Currently, the base has no plans for changes in the treatment process. However, the base did mention that it was investigating the possibility of converting the WWTP to a contractor-run operation. However, there has been no decision and this investigation is still in the preliminary stages.

Appendix E-4

Ellsworth AFB

Wastewater Treatment Train. The Ellsworth AFB WWTP consists of a primary settling basin, trickling filters with secondary clarification, and chlorination. They do not de-chlorinate the final effluent. The average flow through the plant is roughly .15 MGD.

Current NPDES Permit. According to the NPDES monitoring report, the current NPDES permit for Ellsworth AFB contains effluent limitations for BOD, pH, oil/grease, and surfactants. Table E-4-1 shows the effluent limits for these parameters. The actual effluent levels were averaged over a 4 month period; from September 1992 to December 1992.

TABLE E-4-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR ELLSWORTH AFB

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	30/45	14/20
pH	6-9	6.6-7.3
TSS	30/45	21/29
fecal col	1000/2000 (per 100 ml)	17/1242 (per 100 ml)
Oil/grease	10 max	<1

Ellsworth's NPDES monitoring report also gives the levels of two of the above constituents in the raw sewage

(influent). From this information, we can obtain the removal efficiency of the treatment process for these constituents. The results are given in Table E-4-2.

Table E-4-2
PROCESS EFFICIENCIES FOR BOD AND TSS
AT ELLSWORTH AFB.

NPDES Parameter	INFLUENT LEVEL (Monthly avg) (mg/l)	EFFLUENT LEVEL (Monthly avg) (mg/l)	AVERAGE PROCESS EFFICIENCY (%)*
BOD	165	14	92
TSS	183	21	89

* This is found by the following equation:

Avg Eff = [(avg influent - avg effluent)/avg influent]*100

This level of treatment is consistent with the expected (textbook) values for trickling filters.

Base Estimates for Future Requirements. The current NPDES permit for Ellsworth comes up for renewal in 1995. The base indicated they were expecting no changes at this time.

Regulator Estimates for Future Requirements. The state regulator said he was not expecting any major changes to Ellsworth's NPDES permit. He said there may be some minor alterations to the oil/grease and fecal coliform requirements, but did not know any specifics. He said that the base has a history of problems with these constituents and the new permit may include tighter restrictions to force the base to take action.

Compliance Problems. The base has one outstanding NOV for its wastewater treatment program. It was issued for problems with fecal coliform, TSS and oils/grease. The base said that they were working with the state in clearing this NOV by showing that they can consistently stay well below effluent limits for these constituents. The base indicated that they expect this NOV to be cleared in the near future.

Future Plans. The base has no plans for upgrading the treatment processes.

Appendix E-5

Grand Forks AFB

Wastewater Treatment Train. Grand Forks is one of the two bases that use oxidation ponds for secondary treatment. Primary treatment consists only of screening. The base does not chlorinate its effluent. The average flow is .9 MGD.

Current NPDES Permit. Grand Forks' NPDES permit comes up for renewal in 1994. The current NPDES permit has discharge limitations for BOD, pH, TSS, oil/grease, ammonia, chlorine residual, and fecal coliform. There were no actual effluent levels received from the base. Table E-5-1 shows the numerical limits for the permitted constituents.

TABLE E-5-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR
GRAND FORKS AFB

PARAMETER	PERMIT CRITERIA (monthly avg/daily max) (mg.l)
BOD	25/45
pH	6-9 std units
TSS	30/45
oil/grease	10 max
ammonia	report
residual chlorine	.099 daily max
fecal coliform	200/400 (per 100 ml)

Base Estimates for Future Requirements. The base said they were expecting no changes for the new NPDES permit.

However, since the base already reports nitrogen (as ammonia), this may be an indicator that some type of limitation on nitrogen may be anticipated.

Regulator Estimates for Future Requirements. The state regulator said that nutrients may be included in the new permit, but at this time, there was nothing firm.

Compliance Problems. The base has no NOVs for its wastewater treatment plant program. They did not indicate any problems with complying with their permit limitations.

Future Plans. The base is currently planning to increase the capacity of the treatment process.

Appendix E-6

Grissom AFB

Wastewater Treatment Train. Grissom's wastewater treatment process includes primary settling, activated sludge with secondary clarification and chlorination. The average flow through the plant is approximately 1 MGD.

Current NPDES Permit. The NPDES permit for Grissom has been expired for two years. However, the base is working under a continuance order, which means the base is to use the effluent limitations of the previous permit, pending renewal by the state. That permit has discharge limitations on BOD, TSS, pH, ammonia (season dependent), oil/grease, fecal coliform and DO. Table E-6-1 shows the numerical limits for these parameters as well as the actual effluent levels. These levels were averaged over a three month period.

Base Estimates for Future Requirements. The base-level forecast for future permit criteria is for a maximum residual chlorine level and for lower ammonia levels. The base did not specify whether the chlorine residual maximum meant that a de-chlorination process would have to be added or that the amount of chlorine used could be decreased. Also they did not specify whether the lower ammonia levels would be based on the time of year.

TABLE E-6-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR
GRISSOM AFB

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	10/15	5/6
TSS	10/15	3/5
Ammonia summer winter	 2.5/3.8 6.5/9.8	 .2/1* .4/.5
Oil/grease	15 max	< 2
Fecal coliform	200/400 per 100 ml	5/71**
pH	6-9 std units	6.1-7.9
DO	6.0 min day. avg	6.1

* Monitoring reports received from the base only included one "summer" discharge period.

** In the text of the permit it states that "...disinfection should not be practiced between November 1 and March 31". Hence, these numbers do not include that timeframe.

Regulator Estimates for Future Requirements. The state regulators predictions were identical to those of the base. The state felt that some type of dechlorination requirement would be added to the future permit, as well as more stringent ammonia limits. Again, the regulator could not say what those exact numerical limits would be.

Compliance Problems. The base is not working under any NOVs for its wastewater treatment program. They did

indicate that the oil/grease limitation was the hardest requirement for them to meet. This was due mainly to their "problem discharger", which is the vehicle washrack. They are currently looking at several solutions to deal with this problem.

Fort [illegible] The base has no plans to upgrade its domestic wastewater facility.

Appendix E-7

K.I Sawyer

eatment Train. The WWTP at K.I. Sawyer is dvanced domestic WWTPs in the Air Force. primary settling (also used for phosphorus removal), rotating biological contactors with secondary clarification, tertiary sand filters, and then chlorination/de-chlorination. The average flow through the plant is approximately .8 MGD.

Current NPDES Permit. No permit information was received from the base. The base is currently working under a continuance order since the NPDES permit has expired and the state has not yet issued a new one.

Base Estimates for Future Requirements. The base is not expecting any changes in the upcoming NPDES permit.

Regulator Estimates for Future Requirements. The state regulator said that there would be no significant changes in the upcoming permit. However, for the extended future, he indicated that possible changes could include the sampling of, or removal of, metals such as copper, lead, and arsenic.

Compliance Problems. The base has no violations for its wastewater treatment program.

Future Plans. The base has no current plans to upgrade or alter the WWTP.

Appendix E-8

Luke AFB

Wastewater Treatment Train. Luke's wastewater treatment process includes primary settling, trickling filters with secondary clarification and chlorination. The average flow through the plant is approximately .3 MGD.

Current NPDES Permit. Luke's NPDES permit comes up for renewal in 1994. No permit or monitoring reports were received from the base.

Base-level Estimates/Regulator Estimates of Future Requirements. The individual that was contacted at the base had been, until just a few months prior, the state regulator for the base's wastewater program. Hence, both the base-level and state regulatory viewpoint was obtained from this individual. She indicated that there were no expected changes in the base NPDES requirements.

Compliance Problems. The base is currently working under one NOV issued by the state. This NOV is for discharging wastewater with levels of boron and phenols which are higher than state-prescribed minimums. The base has entered into a Federal Facilities Compliance Agreement with the state to clear this violation.

Future Plans. The base is completely upgrading the wastewater treatment facility. They are changing from a trickling filter plant to activated sludge. They are also

adding a tertiary filtration process as well as changing the means of disinfection from chlorination to an ultra-viclet (UV) disinfection process. Additionally, the base is trying to start a 100% wastewater reuse program that would eliminate the NPDES permit except for emergency discharges.

Appendix E-9

McGuire AFB

Wastewater Treatment Train. The first step in the wastewater treatment train at McGuire is a primary settling basin. Ferric chloride is added for phosphorus removal. After the settling basin, the plant has trickling filters with secondary clarification, sand filters, chlorination and dechlorination. The average flow through the plant is 1.2 MGD.

Current NPDES Permit/Future Plans. The NPDES permit for McGuire AFB expired in 1989. The base is working under an Administrative Compliance Order (ACO) issued by the state of New Jersey. Despite its seemingly advanced treatment processes, the WWTP at McGuire was constructed in the 1940's and has difficulty in meeting all of its discharge limitations.

Additionally, the discharge limitations given to McGuire in the ACO are the most stringent set of requirements in this study. No only must McGuire monitor for the conventional pollutants, they must also monitor for DO, TDS, ammonia, phosphorus and alkalinity. Also, they must sample monthly for 13 different heavy metals, cyanide, phenols, acid compounds, pesticides, and volatile organic compounds. Additionally, they must do quarterly acute biomonitoring quarterly, and monthly chronic biomonitoring.

Numerical limits for metals, VOCs and pesticides were to have been set as of 1 Oct 92, yet most of these numbers have yet to be determined.

The base will be connecting to a new wastewater treatment facility a short distance away at Ft Dix. This is scheduled to occur in the latter part of 1994. This connection will eliminate the NPDES domestic wastewater discharge permit for McGuire.

Appendix E-10

Minot AFB

Wastewater Treatment Train. The wastewater treatment process at Minot consists of simple screening and then two sets of oxidation ponds. The base only discharges wastewater 3-4 times a year.

Current NPDES Permit. The state of North Dakota does not have NPDES authority at this time. The requirements for the current permit were promulgated by Region VIII of the EPA. However, the state is expected to gain NPDES authority by the end of the current year (1993).

The current permit for Minot has effluent limitations for BOD, TSS, pH, oil/grease, and fecal coliform, and residual chlorine. Table E-10-1 shows the permit requirements for these pollutants, as well as the actual levels in the discharged effluent over a four month period.

Base Estimates for Future Requirements. The base personnel surveyed indicated that there were no changes anticipated to the future NPDES permit for the base for wastewater effluent discharge levels. however, they do expect a sludge sampling program requirement.

Regulator Estimates for Future Requirements. Since North Dakota's NPDES authority is imminent, the state's wastewater regulatory agency was contacted in lieu of the region. The state regulators said they did not expect any

major changes to Minot's NPDES permit.

TABLE E-10-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR MINOT AFB

PARAMETER	PERMIT REQUIREMENT (mg/l)	EFFLUENT LEVELS* (mg/l) 1A 2A** 3A 10A
BOD	25/45	13/13 20/20 6/6
pH	6-9.5 std units	7.2-8.1 for all outfalls
TSS	30/45	21/21 25/25 9/9
resid. chlorine	report	no chlorination for all outfalls
fecal coliform	200/400	1/1 <1/<1 <10/<10
oil/grease	report if visual	none reported for all outfalls

* Minot discharges from four distinct outfalls.
** There was no discharge from 2A during the period reported.

Compliance Problems. Minot AFB has one outstanding NOV which is for past problems with meeting the TSS requirement. The base indicated they are working with the state to solve the problem and to clear this violation.

Future Plans. Minot is currently increasing the capacity of its treatment process. It is building an additional lagoon so that it will have two full sets of three lagoons each. The base said this would hopefully help solve the TSS problem by having additional retention time on the one set of lagoons.

Appendix E-11

Moody AFB

Wastewater Treatment Train. The WWTP at Moody AFB consists of a settling basin, trickling filter with secondary clarification, tertiary aeration and chlorination. The average flow is .75 MGD.

Current NPDES Permit. The NPDES permit for Moody comes up for renewal in 1995. No other permit information was received from the base.

Base Estimates for Future Requirements. The base said that they were expecting some changes to the NPDES permit when it comes up for renewal. However, they did not know any specifics and said they were expecting changes simply because of the current trend of increasingly stringent environmental regulations.

Regulator Estimates for Future Requirements. The state regulator indicated two possible changes in the future for Moody. These consist of toxicity testing (biomonitoring) and de-chlorination.

Compliance Problems. The base has no NOVs for its wastewater treatment program. The base also said that there was not any particular pollutant limitation that they found difficult to meet.

Future Plans. The base has no future plans for upgrading or changing the WWTP.

Appendix E-12

Patrick AFB

Wastewater Treatment Train. Patrick AFB has two domestic wastewater treatment plants. Both plants use activated sludge, with primary settling and secondary clarification. Both plants chlorinate and de-chlorinate the final effluent. One plant has a tertiary sand filter. Daily flow through both plants is approximately 1 MGD.

Current NPDES Permit/Future Plans. The NPDES permit for Patrick expired in 1990. The base is working under a continuation order from the EPA and state regulatory agency. This continuation order is valid until the base connects to the Cocoa Beach POTW, a regional facility. This connection was mandated by a recently-passed local ordinance which prohibits wastewater discharge of any sort into the local waterway. This connection to the regional facility will eliminate the base's NPDES permit requirement for wastewater. However, the base is expecting some type of pretreatment requirement from the POTW, though they did no know exactly what that requirement would entail.

Appendix E-13

Robins AFB

Wastewater Treatment Train. The wastewater treatment train at Robins consists of a settling basin, trickling filters with secondary clarification, nitrogen removal, tertiary filters and chlorination. The average flow through the plant is between 1.5 and 2 MGD.

Current NPDES Permit. The current NPDES permit comes up for renewal in December 1993. It has effluent limitations for BOD, COD, TSS, ammonia (season dependent), oil/grease, fecal coliform, residual chlorine, and phenols. It also has a twice/year sampling requirement for copper, lead, and silver. Table E-13-1 gives the permit limitations for these parameters as well as the actual effluent level for each. The actual levels were averaged over a four month period

Base Estimates for Future Requirements. The base indicated that they were expecting changes in their future NPDES requirement. These changes include lower BOD, COD, and TSS levels, as well as a requirement for de-chlorination.

Regulator Estimates for Future Requirements. With the exception of a possible chlorine limitation, the state regulator for Robins did not indicate any specific changes to the NPDES permit for the base. He did say that the state

was working on a study for new water quality standards, and that the result of this study could lead to changes for the base.

Table E-13-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR ROBINS AFB

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	15/25	7/18
COD	45/75	67/1064
TSS	15/30	19/89
ammonia	5/7.5	1.2/4.3
oil/grease	10/15	1.7/1.7
pH	6-9 std units	6.3-7.5
resid. chlorine	report	2.4/6.6
fecal coliform	200/400 per 100 ml	0/0
total phenols	.1/.2	.013/.013

Compliance Problems. The base has no outstanding NOV's for its wastewater treatment program. The base did say that the plant did have trouble meeting TSS and COD requirements, but as of yet, nothing has been serious enough to warrant an NOV from the state.

Future Plans. Robins currently has a relatively large and complex MILCON project planned for its wastewater

treatment program. However, only a very small portion will affect the domestic WWTP. This project includes building a dedicated biological treatment process for one of the industrial WWTPs at Robins. The effluent from this new plant may be channeled to mix with the effluent from the domestic plant. By doing so, the base would have to sample from only one point for the two plants. However, this decision has not yet been made, pending state approval.

Another small part of this project that affects the domestic plant is the upgrading of the splitter box which leads into the two primary settling tanks. Currently, the flow cannot be equalized between the two tanks.

Appendix E-14

Scott AFB

Wastewater Treatment Train. The wastewater treatment train for Scott includes primary settling, trickling filters with secondary clarification, and tertiary sand filters. There is also a chlorination and de-chlorination process. The average flow through the plant is approximately 1.5 MGD.

Current NPDES Permit. The base declined to submit their NPDES permit or monitoring report information.

Base Estimates for Future Requirements. The current permit for Scott comes up for renewal in 1994. The base is not expecting any changes to the future permit.

Regulator Estimates for Future Requirements. The state regulator for Scott does not expect any changes for the future permit.

Compliance Problems. The base has no NOV's for its wastewater treatment program. They did indicate that their most difficult criterion to meet was the summer ammonia limitation.

Future Plans. Scott has no plans for adding to or upgrading the WWTP.

Appendix E-15

Shaw AFB

Wastewater Treatment Train. The wastewater treatment train for Shaw AFB consists of aeration, activated sludge with secondary clarification, and tertiary filtration (multi-media). The plant also chlorinates the final effluent. The average flow through the plant is .9 MGD.

Current NPDES Permit. The NPDES permit for Shaw comes up for renewal in October 1993. The current permit has effluent limitations for BOD, DO, TSS, fecal coliform, ammonia, phenols, and residual chlorine. Table E-15-1 shows the numerical limits for these pollutants as well as the levels in the final effluent. The actual effluent level were averaged over a four month period.

Base Estimates for Future Requirements. At the time of this writing, the base is not expecting any changes to the upcoming NPDES permit.

Regulator Estimates for Future Requirements. The state regulator indicated that there would be no significant changes to the NPDES permit for Shaw. He also indicated that in the future, the state of South Carolina will be assessing water quality needs by drainage basin, and that this could have an effect on permitting for all dischargers within the state.

TABLE E-15-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR
SHAW AFB

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	15/30	5/14
TSS	30/60	22/137.5
DO	6.0 min	8
pH	6-8.5 std units	6.3-7.7
ammonia	report/4.0 max	.23/.61
fecal C.	1000/2000 per 100 ml	24/3195*
phenol	report	< 10
resid. chlorine	.1 max	.2

* One month had a max of 14,440 per 100 ml. This made the average high. Without that month, the average weekly max is 394 per 100 ml.

Compliance Problems. The state has no outstanding NOVs for its wastewater treatment program. They did indicate that the two toughest parameters it had to meet were TSS and BOD, although the information in the table show high residual chlorine levels, as well.

Future Plans. The base has an ongoing project to upgrade its equalization basin and sludge digester. It also is constructing a dual ch rination/de-chlorination process. The base indicated that the chlorination/de-chlorination project is a state driven requirement.

Appendix E-16

Tinker AFB

Wastewater Treatment Train. The treatment train at Tinker consists of screening, flocculation and clarification, trickling filters, secondary clarification and pressure filters. The average daily flow through the WWTP is approximately .5 MGD. The plant does not have final chlorination.

Current NPDES Limits. Tinker's NPDES permit comes up for renewal in August of 1993. The current permit was issued by Region 6 of the EPA. However, the State of Oklahoma will be given NPDES authority this summer and hence the new permit will be issued by the state.

The current NPDES permit requires the plant to report on four parameters. These parameters, along with the NPDES average and maximum limits, as well as actual effluent levels, are given in Table E-16-1. This average is taken over the six month period between November 1992 and April 1993.

It is interesting to note that the effluent BOD amount exceeded the NPDES requirement in each of the six months examined, yet the base stated they were under no NOV's from the regulatory agency.

TABLE E-16-1
NPDES PARAMETERS AND EFFLUENT LEVELS FOR
TINKER AFB.

NPDES PARAMETER	PERMIT LEVELS (Month avg/daily max) (mg/l)	ACTUAL EFFLUENT LEVELS (Mon. avg/daily max) (mg/l)
BOD	10/15	13.5/22.5
TSS	15/25	8.6/13.3
Flow	(report)	.42
pH*	Min 6 - Max 9	min 7.1 - max 8.5

* The actual effluent pH is given as the minimum and maximum for the 6 month time period.

Base Estimates for Future Requirements. The base indicated that the expected changes to the NPDES permit would be in the area of metals removal and effluent toxicity (biomonitoring). However, they were unsure as to the specific requirements.

Regulator Estimates for Future Requirements. There was general agreement between the base and the state regulator on the expected changes to the NPDES permit. The regulator indicated that biomonitoring and whole effluent toxicity were going to be included in the upcoming permit. Also, there was a possibility of new requirements concerning certain heavy metals, such as mercury, arsenic, cadmium and chromium.

Additionally, he stated that the base would have to provide additional information on background concentration of contaminants and that there may be a tightening of the

fecal coliform requirement.

Compliance Problems. As mentioned above, the WWTP at Tinker has problems meeting its BOD limit. During the course of the base-level survey, the base indicated that this is indeed the hardest parameter it has to meet.

Future Plans. The base has no plans to upgrade or add-on to the current WWTP.

Appendix E-17

Whiteman AFB

Wastewater Treatment Train. The current wastewater treatment process at Whiteman consists of primary settling and trickling filters with secondary clarification. They do not chlorinate the final effluent. The average flow through the plan in approximately .6 MGD.

Current NPDES Permit. No NPDES permit information was received from the base. The current permit comes up for renewal in 1994.

Base-level Estimates for Future Requirements. The base is expecting changes in upcoming NPDES permits, mainly due to a change in the receiving waters. The base will begin discharging its effluent into a wetlands area. This will be considered a tertiary treatment, and the NPDES limits for some constituents are going to become stricter. For example, according to the base, the current permit BOD and TSS levels are at 30 mg/l and 30 mg/l, respectively. With the new permit, they are expecting these levels to drop to 10 mg/l and 15 mg/l. This is measured as the effluent leaves the wetland area. The base POC indicated that he is expecting no problems with these new levels, since the plant is consistently reaching these levels with secondary treatment only.

The reasoning behind discharging into a wetlands area

is as follows: the base, in cooperation with the state, is experimenting with this approach to determine the applicability and efficiency of using wetlands as tertiary tre ment for domestic wastewater. A substantial amount of research has been done on using wetlands for domestic wastewater treatment, but there is very little in the way of actual experience. For more information on wetlands wastewater treatment, the reader is advised to read Constructed Wetlands for Wastewater Treatment (Lewis Publishers, 1989).

Regulator Estimates for Future Requirements. The state regulator contacted did not mention the new numerical limits given by the base. He simply indicated that the new permit would be based on water quality modeling. He also indicated that there possibly may be added requirements on ammonia removal, as well as phosphorus removal, though the latter would most probably be sometime in the future.

Compliance Problems. According to the POC, the base does not have any violations for its wastewater treatment program.

Future Plans. According to the base POC, the base has no future plans to upgrade the WWTP.

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Vita

Captain Steven R. Ford was born on 1 November 1964 in Provo, Utah. He graduated from Pleasant Grove High School in 1983. He then attended Brigham Young University in Provo, Utah, where he received the degree of Bachelor of Science in Civil Engineering in 1989. Upon graduation, he was commissioned a Second Lieutenant in the United States Air Force. His first assignment was as staff facility programmer at Headquarters, Electronic Security Command (now Air Force Intelligence Command) at Kelly AFB, San Antonio, Texas. He then transferred to the Directorate of Environmental Management at Kelly AFB where he served as project officer for the base underground storage tank program. His next assignment is chief of programming at a classified location.

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One of the major environmental regulations that directly affects the Air Force is the Federal Water Pollution Control Act (FWPCA). The 1972 FWPCA amendments set forth a series of national goals regarding water quality. The main mechanism for achieving these goals was the National Pollutant Discharge Elimination System (NPDES). NPDES is a program requiring dischargers to limit the quantity of pollutants discharged into the recieving waters. This research effort predicts changes in future NPDES permit requirements, and evaluated the capabilities of Air Force wastewater treatment plants (WWTPs) in meeting those future requirements. It was found that future permit requirements will likely include de-chlorination, nutrient removal and possibly metal removal. It was also found that current WWTPs will not be able to meet these requirements. Also, several states are now developing new water quality assessment criteria.

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